R009-P19
ポスター 2 ：9/25　AM1/AM2 （9:00-12:30）

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Development of a photochemical model for the impacts of solar energetic particles on prebiotic chemistry on early Mars

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Understanding the effects of solar energetic particles (SEPs) on the atmospheric chemistry on early Mars is of astrobiological interest, because the precipitation of SEPs into the early Martian atmosphere could have facilitated the prebiotic chemistry. The flare observations of solar-type G stars by Kepler mission suggested that our Sun should have been much more active, and intense SEP events could have hit the planetary atmospheres repeatedly 4 billion years ago (e.g., Lingam et al., 2018). Such recurrent SEP events in the past and high efficiency in the production of amino acids suggested by previous laboratory experiments (Kobayashi et al., 2023). SEPs are therefore considered as one of the key energy sources for prebiotic chemistry on early Mars.

In this study, we developed a photochemical model on the early Martian atmosphere to investigate the contribution of SEPs to production of HCN and H2CO, which are known as the precursors of amino acids and ribose. To take into account the production of hydrogen atom via water cluster ion chemistry properly, we have investigated the dependence of hydrogen atom production rate as a function of the ionization rate. We found that the production rate of hydrogen atoms per one ion pair production reaches unity below the hygropause altitude in CO2-dominated Martian atmosphere, which falls sharply above the hygropause. Application of the parameterization of the production of hydrogen atoms during SEP events to the early Martian neutral atmospheric chemistry will also be presented.

References:

Lingam, M., Dong, C., Fang, X., Jakosky, B., and Loeb, A. (2018). The Propitious Role of Solar Energetic Particles in the Origin of Life, The Astrophysical Journal, 853:10, doi:10.3847/1538-4357/aa9fef.

Kobayashi, K., Ise, J.-i., Aoki, R., Kinoshita, M., Naito, K., Udo, T., Kunwar, B., Takahashi, J.-i., Shibata, H., Mita, H., et al. (2023). Formation of Amino Acids and Carboxylic Acids in Weakly Reducing Planetary Atmospheres by Solar Energetic Particles from the Young Sun, Life, 13, 1103, doi:10.3390/life13051103